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Transit Times and Temperatures of Transcontinental Cut-Flower Shipments

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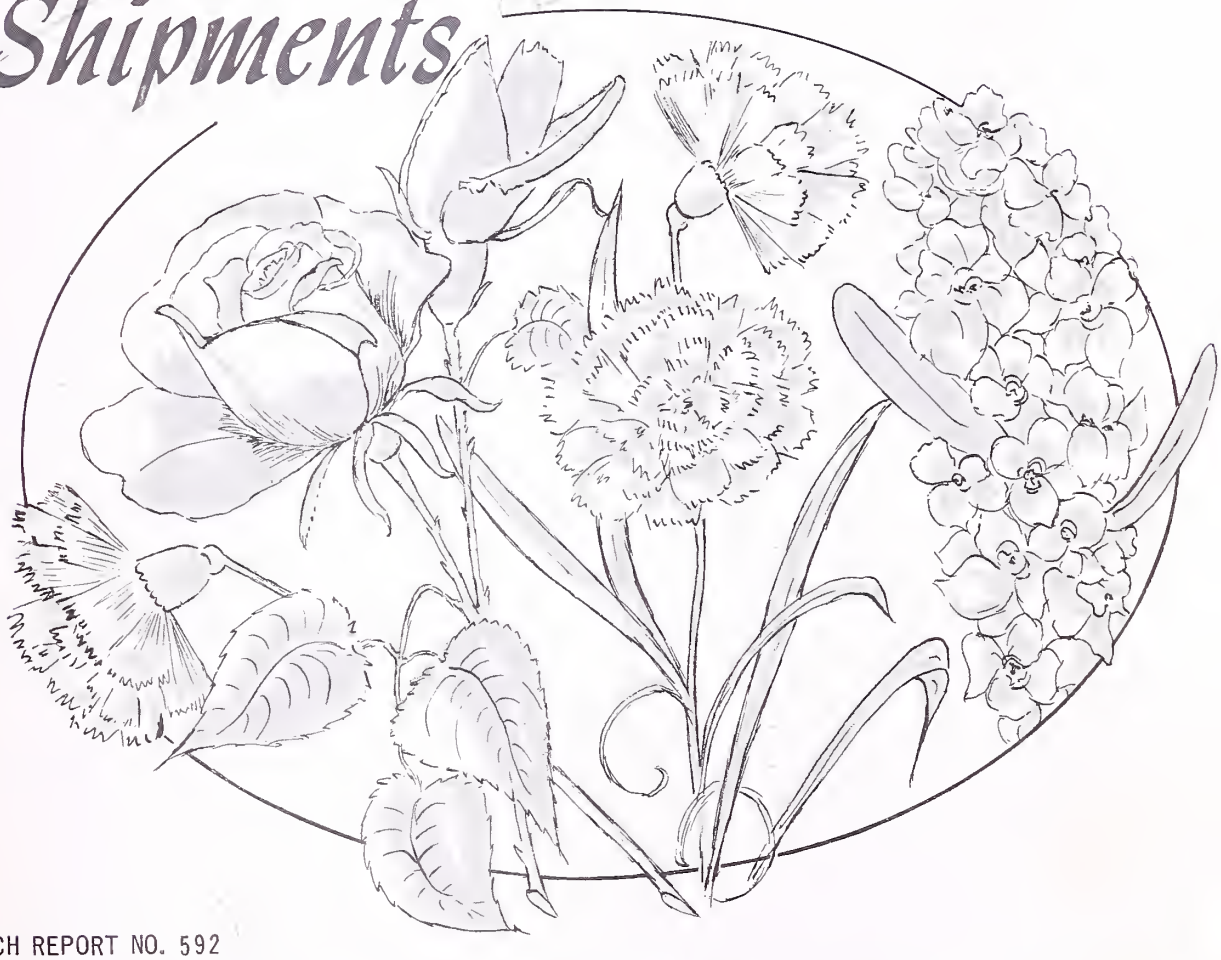

MARKETING RESEARCH REPORT NO. 592
UNITED STATES DEPARTMENT OF AGRICULTURE • AGRICULTURAL MARKETING SERVICE • MARKET QUALITY RESEARCH DIVISION

PREFACE

California is the largest producer of cut flowers in the United States, according to the 1959 Census of Agriculture. The wholesale value of cut flowers in California was about $26.9 million in 1959, nearly 19 percent of the total production of cut flowers in the United States. The value of cut flowers in California was almost equal to that of strawberries. Almost 60 percent of the cut flowers produced in California are sold out of the State, mostly in the large eastern population centers. (Trends in Cut Flower Industry, by W. Miklius and D. B. DeLoach. Calif. Agr. 13(11): 2. 1959.)

Transport to the east is made predominantly by air, and shippers have estimated annual transit losses of over $400,000, aside from unmeasured quality deterioration that reduces the market value of flowers. These losses indicated the need for research to improve transit temperatures, packaging, and handling procedures. The study is part of a broad program of continuing research by the Agricultural Marketing Service to reduce losses in the quality of products in marketing channels.

ACKNOWLEDGMENTS

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The California Floral Traffic Conference, San Francisco, Calif., for providing financial assistance and helping arrange shipping tests.

The Southern California Floral Association, Los Angeles, Calif., for assistance in arranging shipping tests.

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The following receivers for assistance in wholesale handling: Hall Wholesale Florists, Orlando, Fla.; Parks Gardens, Pharr, Tex.; S. S. Pennock Co., New York, N. Y., Washington, D. C., and Orlando, Fla.; Rutig, Gaston, and Costa, Inc., New York, N. Y.; A.Sauter Co., New York, N. Y.; Claymore G. Sieck Wholesale Florists, Washington, D. C.; and Harry Vlochs, Inc., New York, N. Y.

The American Box Company, Newark, Calif., for supplying experimental containers.

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The Wilsey-Bennett Trucking Co., San Francisco, Calif., for assistance in shipping tests.

The following staff members of the Horticultural Crops Branch: J. M. Lutz, assistant chief of Branch, Beltsville, Md., and H. B. Johnson, senior plant pathologist, Harlingen, Tex.

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Washington, D. C. March 1963

TRANSIT TIMES AND TEMPERATURES OF TRANSCONTINENTAL CUT-FLOWER SHIPMENTS

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Horticultural Crops Branch
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SUMMARY AND CONCLUSIONS

Temperatures recorded in test shipments of cut flowers from California to eastern and southeastern markets were mostly in the 50° to 70° F. range, but some summer temperatures were as high as 90° and some winter temperatures as low as 34°. Most varieties of flowers keep best in the 33° to 40° range.

Improved packaging, such as the "bunker" box, provided lower transit temperatures than those obtained in conventional containers. The bunker box has compartments at each end to hold the ice, and with further refinements should offer a practical way of shipping flowers that need the protection afforded by package ice.

Total times from packing to delivery ranged from 18 to 35 hours and averaged about 25 hours. A major portion of this time was spent at place of origin and at destination. Flying times made up less than 30 percent of the total, and the remainder was spent at the packing plant, in the consolidating truck, at the air terminals (west and east coasts), at transfer points, and in the distributing truck going to the wholesale market.

The amount of time spent at origin and destination areas and the temperatures recorded there, indicate that more effort should be made to protect flowers from extremes in temperature at these points in the transit system.

Flower quality was affected by differences in transit temperatures and times. Quality differences were manifested in the opening of rosebuds, decay of stock, chrysanthemums, and asters, wilting and many less tangible quality factors.

BACKGROUND

The time during which cut flowers are in transit is usually considered to be relatively short due to the use of jet air transport. However, transit times are actually much longer than air schedules would indicate, since for practical purposes they include the total time from packing at shipping point to delivery at the wholesale florists. This time is composed of an indefinite period spent at the packing plant awaiting pickup by a flower consolidator, the time spent in the consolidating truck, the time at the air terminal awaiting loading on the plane, the actual time in the air, the time at transfer points, the time at the terminal airport, and the time required to deliver the shipment to the wholesaler at the destination. The responsibility, therefore, for proper handling and refrigeration lies with the packer, the consolidator, the air terminal facility, the airlines, and the agency delivering the flowers at destination.

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[1] Dr. Harvey is principal plant pathologist and Dr. Uota, senior physiologist, at Fresno, Calif.; Dr. Segall is plant pathologist at Orlando, Fla.; and Mr. Ceponis is plant pathologist at New York, N. Y.

Tests conducted in the 1960-61 season demonstrated some of the temperatures and transit times characteristic of cut-flower shipments.[2] Since that time certain schedules have been shortened and a number of transfers have been eliminated, requiring that additional test shipments be made. There have also been developments in packaging that require the determination of their effects on transit temperatures.

METHODS

The test shipments were made under conditions that simulated commercial handling as closely as possible. Recording instruments and test bunches of flowers were placed in commercial packages at the packing plant and were recovered at the wholesalers.

In most shipments, two recording thermometers were placed in each carton of flowers. One instrument was placed in the center of the package and the other at the end adjacent to the blooms.

The condition of the flowers was evaluated at the destination by U. S. Department of Agriculture scientists who held the flowers to determine display life at temperatures commonly used by the trade.

RESULTS

Rose Shipments in the "Bunker" Box

Previous tests[3] indicated that there was a wide variation in temperature between the center and ends of cartons in which roses were shipped. Ice is usually placed in the center of the carton, and temperatures rapidly approached the temperature of the ice in this location. However, temperatures near the blooms, which are positioned at the ends of the cartons, were as much as 29 degrees warmer than at the center.

To make temperatures more uniform, a liner was designed which provided ice bunkers at each end of the box. In addition, the liner was raised from the bottom of the box and was perforated to facilitate convection of cold air within the package (see appendix).

Shipment to New York, N. Y.

Temperatures in a rose shipment from Mt. Eden, Calif., to New York, N. Y., are shown in figure 1. These flowers were shipped in the experimental bunker box on September 12, 1961. Each bunker contained 8 pounds of crushed ice placed in polyethylene bags. An additional bag of crushed ice was placed in the center of the carton. The bunker box had the same insulation (fiber glass) as the conventional box.

Transit temperatures.--The flowers were at 50° F. when packed, and temperatures at the ends of the packages remained between 40° and 50° until arrival in New York. Shortly after arrival, the ice in the bunkers had evidently melted and temperatures rose to 66° during the time required to deliver the roses to the wholesaler.

Temperatures in the center of the box remained mostly below 50° F. although there was a slight temperature rise before the shipment left San Francisco.

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2 Harvey, J. M., Uota, M., Segall, Ralph H., and others. Transit Temperatures in Cut Flowers Shipped From California. U.S. Dept. Agr. AMS-459, 11 pp. 1962.

3 See footnote 2.

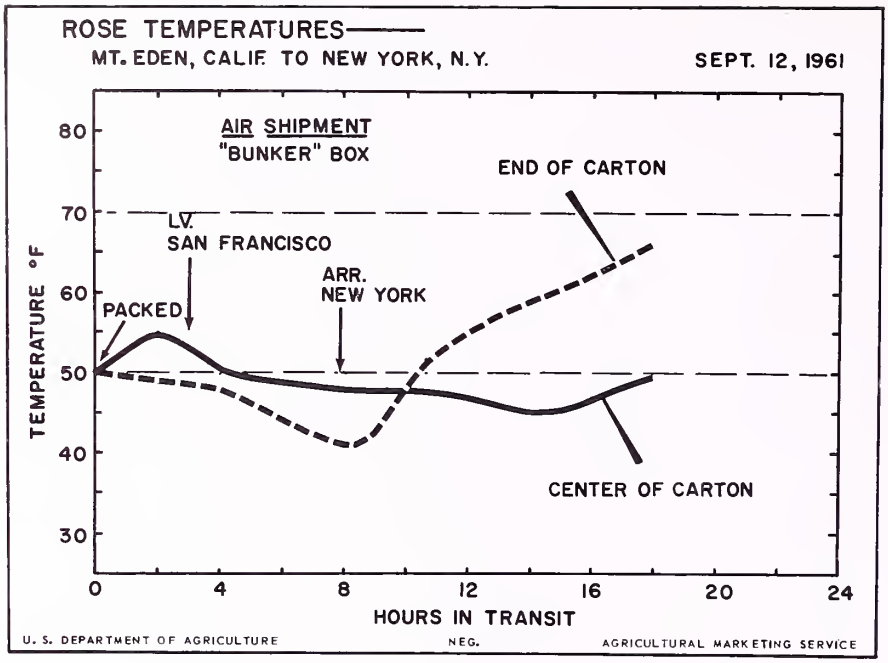

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Figure 1.--Transit times and temperatures of roses shipped by air from Mt. Eden, Calif., to New York, N. Y., September 12, 1961. Temperatures at one end and at the center of a bunker box are shown.

Time in transit.--A total of about 18 hours elapsed from time of packing to delivery. Only about 5 hours of this period was spent on the airplane. Almost 10 hours elapsed from the time of arrival in New York until the flowers were delivered to the wholesaler.

Arrival condition.--The ends of the cartons were water soaked, indicating that a heavier polyethylene bag should have been used for the ice. On arrival and during holding there was little difference in the condition of flowers shipped in the bunker box or in a conventional carton. Due to malfunction of the recorders, no temperatures were obtained in the conventional carton. The flowers remained salable for about one day at 60° F.

Shipment to Washington, D. C.

Another rose shipment was made from San Mateo, Calif., to Washington, D. C., on the same day (fig. 2). Both a bunker box and a conventional box were shipped, but insulation was not used in the bunker box. Twelve pounds of crushed ice in polyethylene bags was placed in each end of the carton and 10 pounds of unbagged ice was placed between paper layers in the top center of the carton.

Transit temperatures.--The flower temperatures at time of packing averaged 68° F. The temperature recorders failed in the conventional box, but temperatures in the ends of the bunker box dropped to about 50° and remained between 50° and 55° until the flowers were delivered.

Temperatures in the center of the box dropped to a low of 37° F. and remained close to 40° during most of the trip.

Time in transit.--A total time of about 22 hours elapsed from packing to delivery. Seven hours of this time was spent before the flowers left San Francisco. The shipment was on the plane about 11 hours, including a 2-hour stopover in St. Louis. About 3 hours elapsed from arrival to delivery.

Arrival condition.--The ice had all melted in the bunkers, but a little was left in the center of the carton when it was opened by the wholesaler. The polyethylene bags had leaked, leaving water in the bottom of the carton.

In the shipment, the condition of the roses was much better in the bunker box than in the conventional carton. The difference was evidenced in the tightness of the buds. Those in the conventional box had opened to a much greater extent than those in the bunker box (fig. 3).

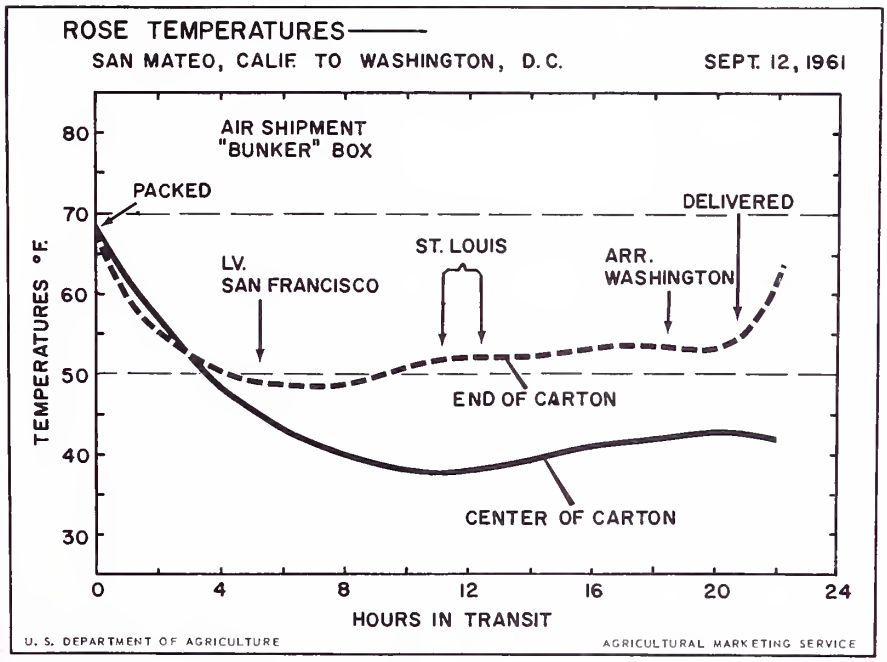

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Figure 2.--Transit times and temperatures of roses shipped by air from San Mateo, Calif., to Washington, D. C., September 12, 1961. Temperatures at one end and at the center of a bunker box are shown.

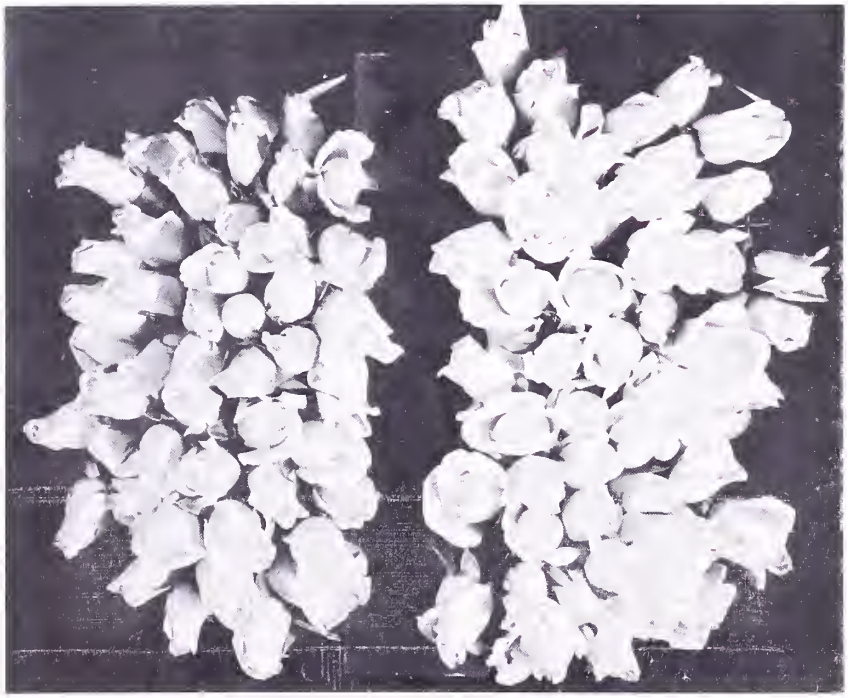

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Figure 3.--Arrival condition of rosebuds (Yellow Rapture) shipped by air from San Mateo, Calif., to Washington, D. C. Left, buds shipped in bunker box; right, buds shipped in conventional container. Because of higher temperatures, buds in the conventional shipment opened more than those in the bunker box.

Shipment to Orlando, Fla.

A rose shipment was also made from Mt. Eden, Calif., to Orlando, Fla., on May 22, 1962 (fig. 4), comparing a conventional box and a bunker box without insulation.

Temperatures in transit.--In this shipment, the flowers were held overnight in a cold room before shipment on an early-morning flight. This procedure diminished the contrast between temperatures in the bunker and the conventional box; however, temperatures in the bunker box were slightly lower than those in the regular box. Temperatures at packing were about 55° F. During holding in the cold room the temperatures at the end of the bunker box dropped to a low of 33° while those in the conventional box dropped to 38°. On removal from the cold room, the temperature in the conventional box rose rapidly, reached a high of about 70° during a transfer at Houston, Texas, and remained near that temperature until arrival in Orlando. Temperatures in the bunker box rose more slowly and were slightly below those in the conventional box during transit.

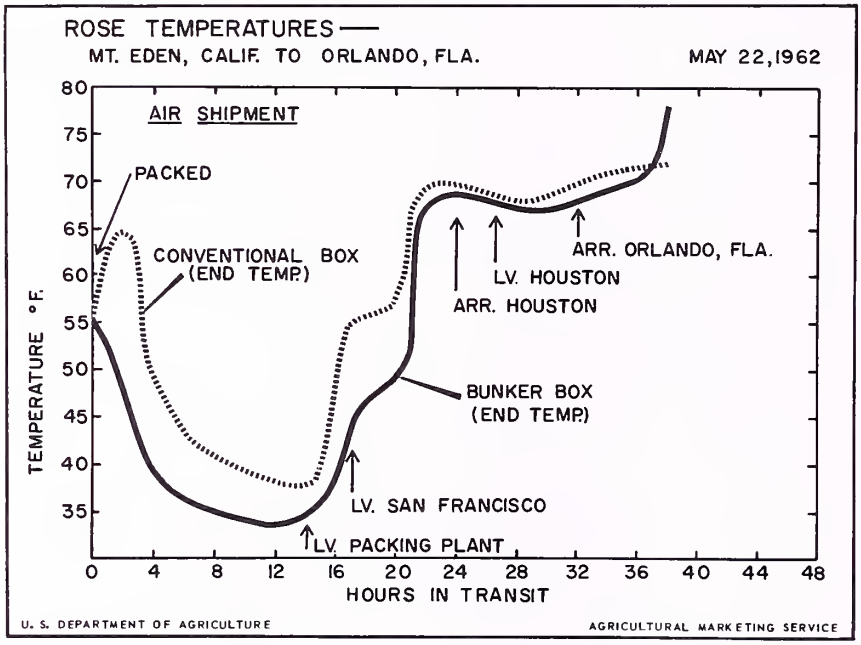

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Figure 4.--Transit times and temperatures of roses shipped by air from Mt. Eden, Calif., to Orlando, Fla., May 22, 1962. Comparison of temperatures at ends of the bunker box and the conventional box.

Time in transit.--The total time in transit was about 38 hours, of which 14 hours was spent at the packing plant (in the cooler), about 3 hours from the packing plant to loading on the plane in San Francisco, 2 hours at a transfer point, and about 13 hours on the plane. About 6 hours elapsed from arrival in Orlando to delivery.

Arrival condition.--The flowers in both containers were in good condition on arrival, and temperature differences were not great enough to affect condition on arrival.

Carnation Temperatures in Transit

Carnations were shipped from Encinitas, Calif., to Washington, D. C., on February 19, 1962 (fig. 5). The flowers were packed in the conventional carton without package ice.

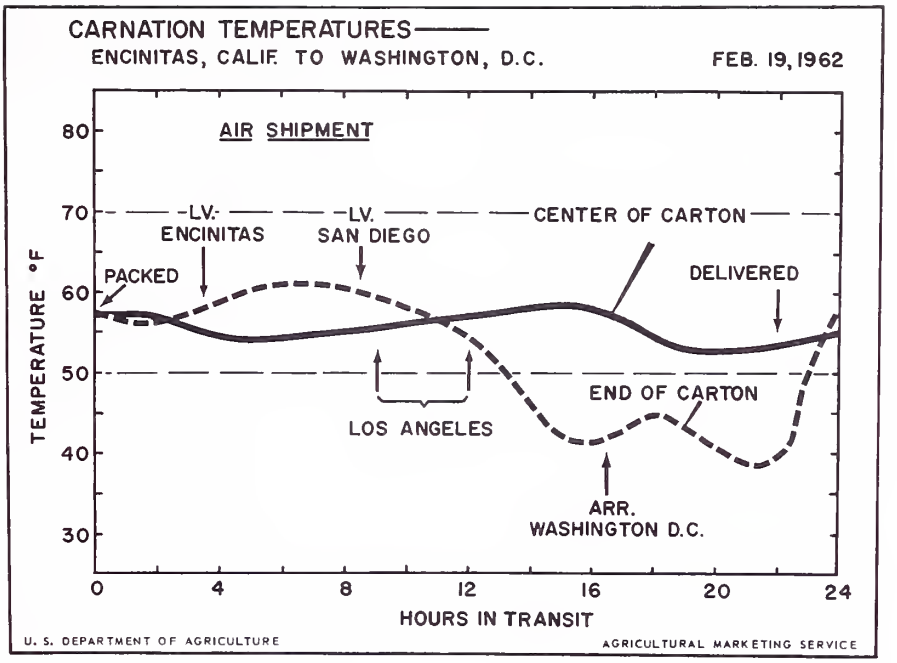

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Figure 5. --Transit times and temperatures of carnations shipped by air from Encinitas, Calif., to Washington, D. C., February 19, 1962. Temperatures at one end and in center of carton are shown.

Transit temperatures. --Temperatures at time of packing were about 57 °F. in the end of the carton. There was a slight rise to about 61° between the shipping point and the San Diego airport. The temperature dropped quite rapidly after the flowers were transferred to another plane at Los Angeles and reached a low of 40°. There was a slight rise following arrival in Washington and temperatures dropped to 38° during delivery. The temperature in the center of the carton remained fairly constant, near 55°.

Time in transit. --The total time from packing to delivery was about 22 hours. Three hours elapsed before the flowers left the packing shed, another 5 hours before leaving San Diego, and about 3 hours during the transfer in Los Angeles. The flowers were in the air about 6 hours, and 5 hours elapsed between arrival and delivery.

Arrival condition. --The carnations were in good condition on arrival and after holding 4 days at 40° F. However, they were completely unsalable after one day at 70° due to "sleepiness." This result was probably due to the fact that apples were stored in the same building as the carnations. Carnations are susceptible to the minute amounts of ethylene produced by apples. Even though they were stored in separate cold rooms, apparently there was enough ethylene in the air to induce sleepiness.

Stock Temperatures in Transit

Shipment to New York, N. Y.

A shipment of stock was made from Encinitas, Calif., to New York, N. Y., on February 19, 1962 (fig. 6). The flowers were packed in the conventional fiberboard carton without ice.

Transit temperatures. --Temperatures at time of packing were about 55° F. The temperature in the end of the box rose gradually to a high of 65° on arrival in New York. During delivery there was a sharp drop to 47°. There was less temperature fluctuation in the center of the carton which remained between 48° and 60°.

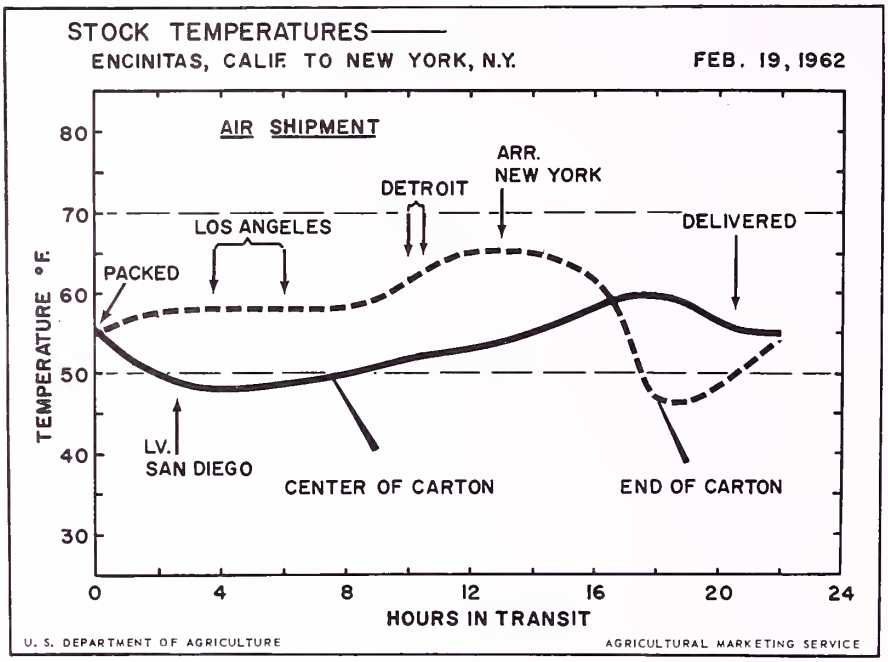

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Figure 6.--Transit times and temperatures of stocks shipped by air from Encinitas, Calif., to New York, N. Y., February 19, 1962. Temperatures at one end and in center of carton are shown.

Time in transit.--A total time of 21 hours elapsed from packing to delivery. About 3 hours was spent from time of packing to leaving San Diego and about 3 hours at various transfer points and stopovers. The flowers were in the air about 7 hours, and about 8 hours elapsed between arrival in New York and delivery.

Arrival condition.--The stocks were rated fair to good on arrival, and their condition improved when the stems were placed in water. They remained salable after 3 days at 40° F. and 2 days at 70°.

Shipment to McAllen, Texas

Another stock shipment in conventional cartons was made to McAllen, Texas, on the same day, February 19 (fig. 7).

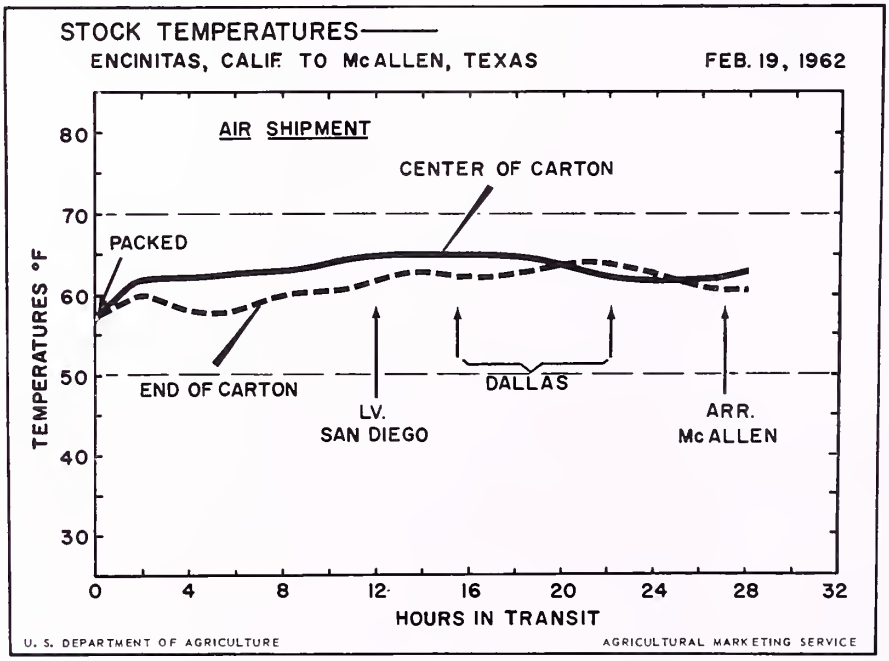

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Figure 7.--Transit times and temperatures of stocks shipped by air from Encinitas, Calif., to McAllen, Tex., February 19, 1962. Temperatures at one end and in center of carton are shown.

Transit temperatures.--The temperatures at the ends and center of the carton remained quite constant during transit at this season of the year. The temperature at the start was 57° F. and remained between 60° and 65° during most of the time.

Time in transit.--Air connections to this market were somewhat difficult and there was a considerable delay at the Dallas transfer. The flowers had a wait of almost 12 hours between packing and leaving San Diego, a 6-hour wait at transfer in Dallas, and were in the air about 8 hours. They were picked up promptly after arrival at McAllen, Tex.

Arrival condition.--The stock remained salable after 4 days at 40° F. and an additional 4 days at 70°.

Shipment to Orlando, Fla.

A summer shipment of stocks in conventional cartons was made from Los Angeles, Calif., to Orlando, Fla., on August 9, 1961 (fig. 8). The cartons were shipped by two different routes and no ice was used.

Transit temperatures.--The temperature at time of packing was about 70° F., after which there was a gradual warming of flowers shipped by both routes to the 80° to 85° range. Route B was slightly warmer than route A.

Time in transit.--Flowers shipped by route A spent a total of 28 hours from packing to delivery. About 7 hours was spent from packing to leaving Los Angeles, about 5 hours in the air, and about 13 hours at a transfer point. About 3 hours was spent from arrival to delivery.

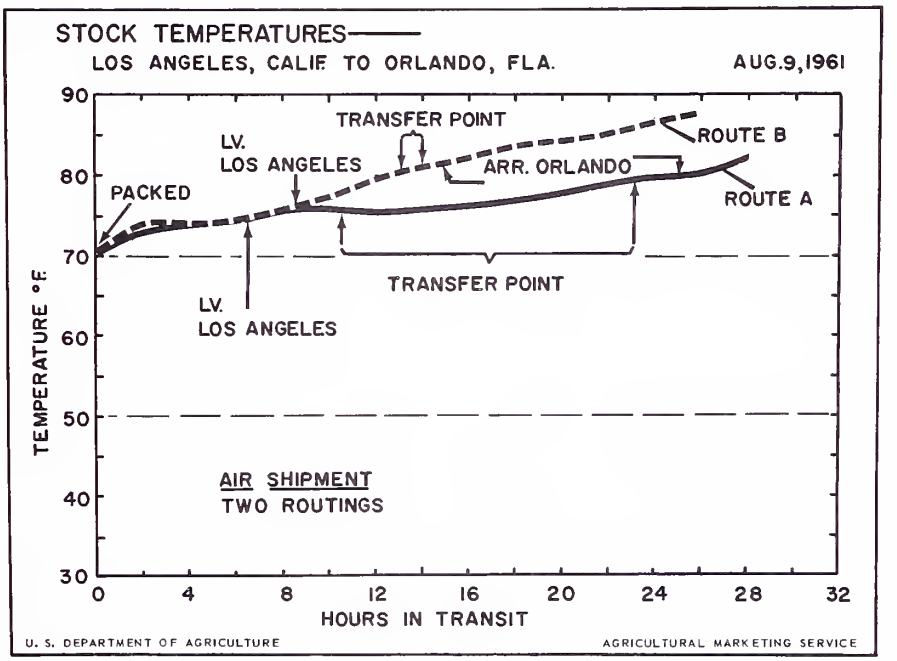

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Figure 8.--Transit times and temperatures of stocks shipped by two different air routes from Los Angeles, Calif., to Orlando, Fla., August 9, 1961. Temperatures shown are averages of those recorded in three cartons shipped by each route.

Flowers shipped via route B had a total time in transit of 26 hours. About 9 hours was spent from packing to leaving Los Angeles, about 5-1/2 hours on the plane, about 1 hour at a relatively quick transfer, and 10 hours between arrival and delivery.

Arrival condition.--All the stocks were very wilted on arrival, and temperatures of the blooms taken manually at delivery indicated 91° F. However, when the stems were placed in water, the flowers recovered after 1 day at 40°. After storage for 4 days at 40°, colored stocks were all unsalable after 1 day at 70° and white stocks after 2 days.

Effect of Route on Temperature, Time, and Condition

Shipment of Mixed Flowers to New York, N. Y., October 5, 1961

Mixed flowers were shipped from Los Angeles, Calif., to New York, N. Y., on October 5, 1961 (fig. 9). Two cartons were shipped by each of three routes. The conventional carton was used and some block ice and crushed ice was used on roses, which were included. All flowers were shipped on the same day and left Los Angeles about the same time.

Transit temperatures.--The temperatures at time of packing were about 66° F. and remained about the same on the three routings until departure from Los Angeles.

Flowers shipped by route A dropped to 34° F. by the time the shipment reached New York. The temperature rose to the 50° to 55° range after arrival.

Temperatures in route B were intermediate, dropping to a low of 53° F. after leaving Los Angeles. There was a gradual increase to about 60° during the latter part of the transit period and after arrival in New York.

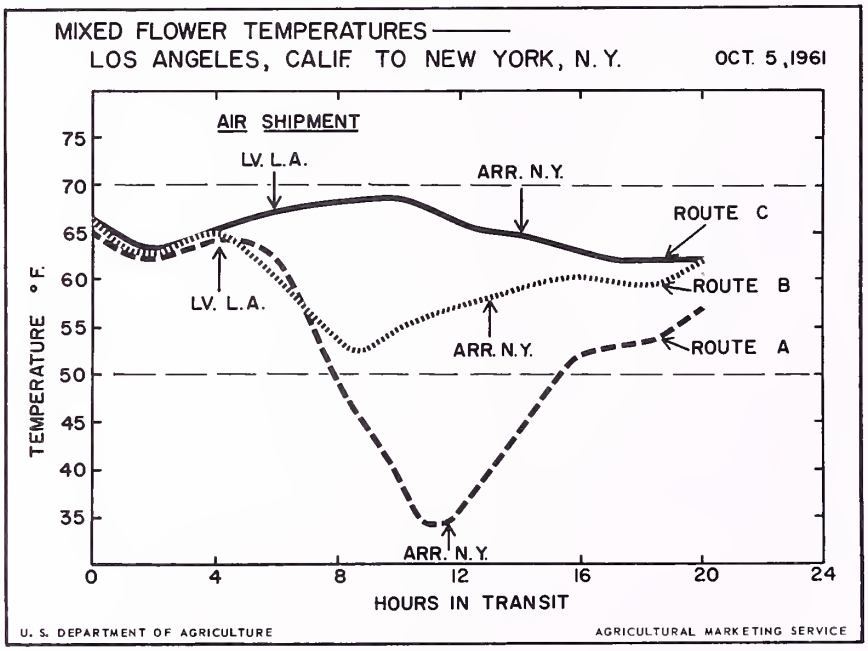

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Figure 9.--Transit times and temperatures of mixed flowers shipped by three different air routes from Los Angeles, Calif., to New York, N. Y., October 5, 1961. Temperatures shown were recorded near ends of cartons; they represent averages of temperatures in two cartons shipped by each route.

Flowers shipped by route C remained in the 65° to 70° F. range for most of the time in transit.

Time in transit.--All three shipments required about 20 hours from time of packing to delivery in New York. Four to six hours were spent before leaving Los Angeles airport, 7 to 9 hours on the plane, and 6 to 8 hours from arrival to delivery.

Arrival condition.--There was some ice remaining in all three shipments on arrival, but there were distinct differences in the condition of the flowers.

Yellow Rapture roses shipped via route A had about 44 percent of the blooms fully open on arrival; about 48 percent of those shipped via route B were fully open; and about 68 percent of those shipped by route C were fully open. These differences were less apparent after the roses were held 4 days at 40° F., and even less so after an additional 2 days at 70°.

Red Delight roses shipped via route A had about 40 percent of the blooms fully open on arrival; about 64 percent of those shipped via route B were fully open; and about 56 percent of those shipped via route C were fully open. These relative differences were still apparent after the roses were held 4 days at 40° F., but opening was about equal after an additional day at 70°.

Stocks shipped via route A had greener leaves and less petal decay than those shipped via route C.

No differences were observed in chrysanthemums, which are hardier than the other flowers included in the shipment.

Shipment of Mixed Flowers to New York, N. Y., December 13, 1961

Another shipment of mixed flowers was made on December 13, 1961, using the same routes (fig. 10). No ice was used at this particular time of year.

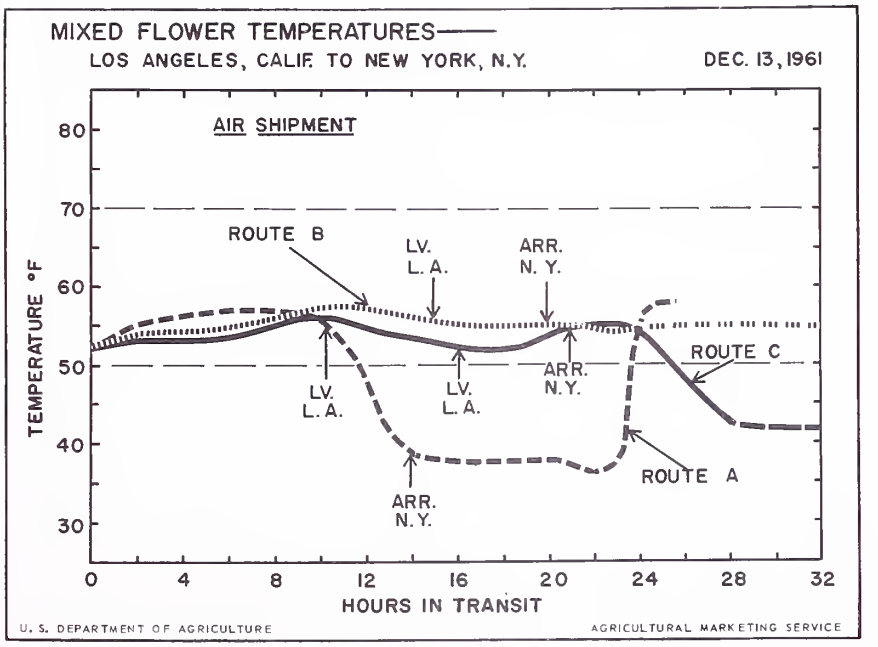

Figure 10.--Transit times and temperatures of mixed flowers shipped by three different air routes from Los Angeles, Calif., to New York, N. Y., December 13, 1961. Temperatures shown were recorded near ends of cartons.

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Transit temperatures. --Temperatures at time of packing were about 52° F., and they remained in the 52° to 57° range until departure from Los Angeles. Flowers shipped by route A were subjected to the coldest temperatures in transit, dropping to a low of 38° by arrival in New York. There was a further drop to about 36° during delivery, after which the flowers warmed rapidly to about 60°.

Temperatures of flowers shipped by routes B and C remained in the 52° to 57° range until after arrival in New York. Temperatures in route C dropped rapidly following arrival.

Time in transit. --Flowers shipped by route A were in transit for 25 hours, and those shipped by the other two routes took about 35 hours. The time between packing and leaving Los Angeles was about 9 hours for route A, 15 hours for route B, and 16 hours for route C. All three shipments were in the air about 5 hours. The time between arrival and delivery was about 11 hours for route A, 14 hours for route B, and 15-1/2 hours for route C.

Arrival condition. --The general condition of the flowers on arrival was poor. There was considerable wilting, and stocks shipped via route B had more decay than those shipped via the other routings. Crown asters had more decay when shipped by route B or C than when shipped by route A. Yellow chrysanthemums also had more decay when shipped by routes B or C than by route A.

Average Transit Times

The average transit times for cut flowers shipped from California to eastern and southeastern markets are shown in figure 11. All shipments made to eastern markets (New York, N. Y., or Washington, D. C.) were made on through planes and involved no transfers en route. Some time was spent at transfer points when flowers were shipped to the Southeast. All shipments shown originated in either the Los Angeles or the San Francisco area.

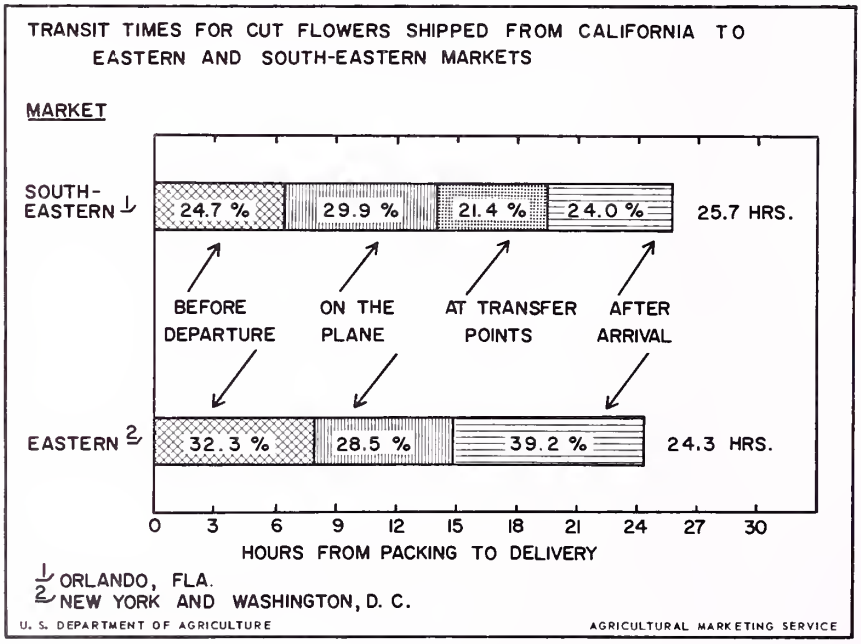

Figure 11. --Average time from packing to delivery of cut flowers shipped by air from California to eastern and southeastern markets in the 1961-62 season.

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For flowers shipped to the Southeast, an average time of 25.7 hours was required from packing to delivery. Of this time, only 29.9 percent was spent on the plane; the rest of the time was spent on the ground--24.7 percent before departure, 21.4 percent at transfer points, and 24 percent between arrival and delivery.

In eastern shipments, the average time from packing to delivery was 24.3 hours. About 28.5 percent of this time was spent on the plane and the remainder at origin or destination. Almost 40 percent of the time was spent between arrival at eastern terminals and delivery to the wholesaler.

APPENDIX

Laboratory Tests With the Bunker Box

To evaluate the bunker box under controlled conditions, thermocouples were placed in cut roses at the center and at each end of the experimental container and in a conventional carton. Crushed ice was placed between the layers of stems in the conventional carton, as is done commercially. In the bunker box a similar amount of ice was placed in polyethylene bags, which were inserted into the two end bunkers of the container.

The cartons were held in a room at a constant 70° F., and at intervals an infrared lamp was placed 24, 36, or 40 inches from one end of the carton to simulate placing a package in the sun during commercial handling.

Temperatures in the center of the conventional container, adjacent to the ice (fig. 12), quickly dropped below 40° F. and remained between 34° and 38° for the duration of the test (24 hours). The temperatures at the ends of the container, however, were only slightly below the ambient room temperature; when the infrared lamp was turned on, the temperature of the roses adjacent to the exposed end increased rapidly.

Temperatures in the bunker box (fig. 13) dropped gradually below the ambient temperature to about 60° F. There was little variation in flower temperatures at the different positions in the container. When the infrared light was turned on, there was a negligible rise in temperature within the box although the wall temperatures were 76° when the bulb was 36 inches away and 95° when it was 24 inches away from the box. The ice in the bunkers provided good protection against the radiant heat.

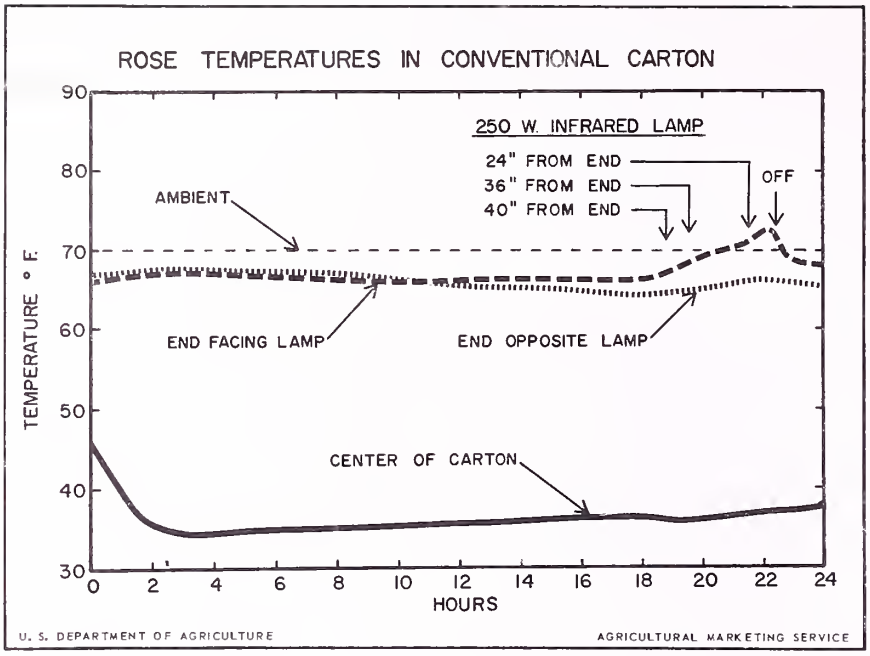

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Figure 12. --Laboratory test of temperatures in a conventional rose carton. Infrared lamp was placed at various distances from one end of the carton at times indicated.

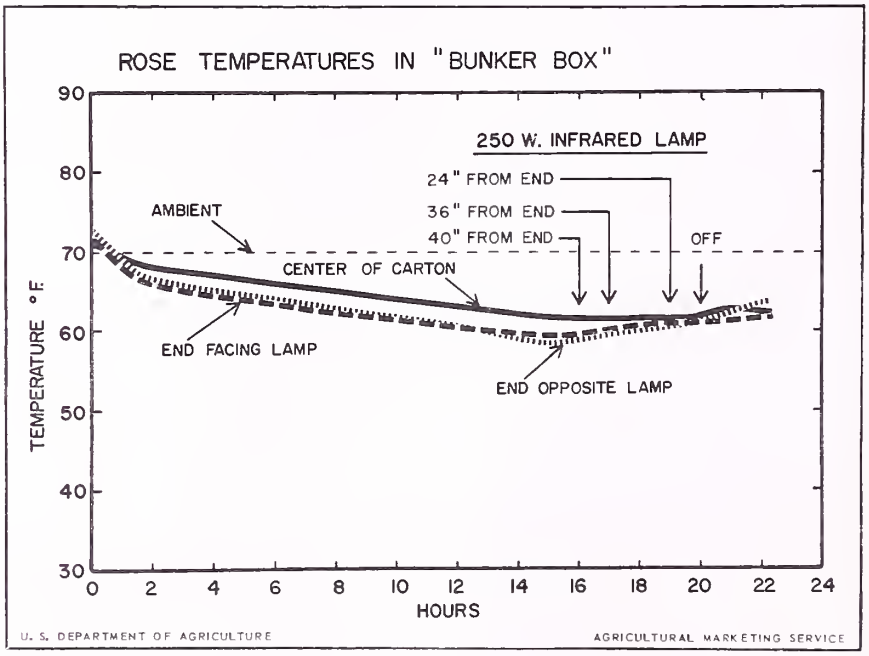

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Figure 13. --Laboratory test of temperatures in an experimental bunker box packed with roses. Infrared lamp placed at various distances from one end of the carton at indicated times.